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# AVEVA™ PI Server Analysis: Expression Tips and Tricks

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# Agenda

- Intros
- Tips and Tricks for expression analyses
  - Use Variables
  - Data Density and Data Pattern
  - Input Attributes
  - Scheduling
- Monitoring the PI Analysis Service and analyses
  - Identifying trouble analyses/PI Analysis Service
  - New tools to identify poorly performing analyses
- Questions

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# PI Analytics: Expression Analysis Best Practices



# Asset Analytics – An Introduction

- Analytics are part of the PI Asset Framework (PI AF)
- Allow you to generate new streams of information, written back to PI
  - **Expression** – Perform calculations on existing data points
  - **Rollup** – Aggregate several AF attributes
  - **Event-based** – Generate event frames based on user-defined triggers
- Build analyses via PI System Explorer
- Use the PSE Management plugin to manage your analytics

The screenshot shows the 'Temperature' analysis configuration window. It has tabs for General, Child Elements, Attributes, Ports, Analyses, Notification Rules, and Version. The 'Analyses' tab is active, showing a table with columns for Name and Backfilling. A single analysis is listed: 'Temperature Hourly Delta' with a green checkmark in the Backfilling column. Below this, there is a section for 'Add a new variable' with a table for Name, Expression, and Output Attribute. The table contains one entry: 'Variable1' with the expression 'Forecasted Hourly Temperature' - 'Current Temperature' and the output attribute 'Temperature Hourly Delta Output'. An 'Evaluate' button is located to the right of the table.

Name	Expression	Output Attribute
Variable1	'Forecasted Hourly Temperature' - 'Current Temperature'	Temperature Hourly Delta Output

The screenshot shows the 'Functions' and 'Management' tabs. The 'Functions' tab is active, showing a list of functions on the left: FindEq, FindGE, FindGT, FindLE, FindLT, FindNE, FirstValue, Float, Floor, Format, Frac, HasChanged, HasValueChanged, Hour, and If. The 'Management' tab is also visible, showing a table of analyses. The table has columns for Status, Element, Name, Template, and Backfilling. The table contains 10 rows of data, all with a green checkmark in the Status column and a green checkmark in the Backfilling column.

Status	Element	Name	Template	Backfilling
✓	AssetUOM	Custom UOM EF	Low Tank Temperature	✓
✓	Velocity Terminals\Locations\Montreal\RC1Testtank	Low Tank Temperature	Low Tank Temperature	✓
✓	Velocity Terminals\Locations\Tokyo\Tank07	Low Tank Temperature	Low Tank Temperature	✓
✓	Velocity Terminals\Locations\Tokyo\Tank06	Low Tank Temperature	Low Tank Temperature	✓
✓	Velocity Terminals\Locations\Tokyo\Tank05	Low Tank Temperature	Low Tank Temperature	✓
✓	Velocity Terminals\Locations\Sydney\Tank10	Low Tank Temperature	Low Tank Temperature	✓
✓	Velocity Terminals\Locations\Sydney\Tank09	Low Tank Temperature	Low Tank Temperature	✓
✓	Velocity Terminals\Locations\Sydney\Tank08	Low Tank Temperature	Low Tank Temperature	✓
✓	Velocity Terminals\Locations\Montreal\Tank04	Low Tank Temperature	Low Tank Temperature	✓
✓	Velocity Terminals\Locations\Montreal\Tank03	Low Tank Temperature	Low Tank Temperature	✓
✓	Velocity Terminals\Locations\Montreal\Tank02	Low Tank Temperature	Low Tank Temperature	✓

# Tip #1: Use Variables

What is easier to calculate if we need to do several tasks in parallel?

- $$X = (V_1 * T^{V_2} + V_3) * He * \frac{\frac{\bar{M} * p}{\mathbb{R} * T}}{\frac{\bar{M} * 611.2 * \exp\left(\frac{17.62 * T}{243.12 + T}\right)}{\mathbb{R} * T}}$$

- $$p_{sat} = 611.2 * \exp\left(\frac{17.62 * T}{243.12 + T}\right)$$

- $$f = \frac{\bar{M} * p}{\mathbb{R} * T}$$

- $$f_{sat} = \frac{\bar{M} * p_{sat}}{\mathbb{R} * T}$$

- $$\rho = \frac{f}{f_{sat}}$$

- $$V = (V_1 * T^{V_2} + V_3) * He$$

- $$X = V * \rho$$

- where

- T, p are measurement data

- $V_1, V_2, V_3, He, \bar{M}, \mathbb{R}$  are (material-specific) constants



# Use Variables

What is easier to calculate if we need to do several tasks in parallel?

- Keep analysis from doing identical tasks multiple times
- Avoid multiple calls for the same data
- Simplify scheduling
- More readable for users
- Keep syntax simple
  - Speeds up evaluation

# Tip #2: Data Density and Data Patterns

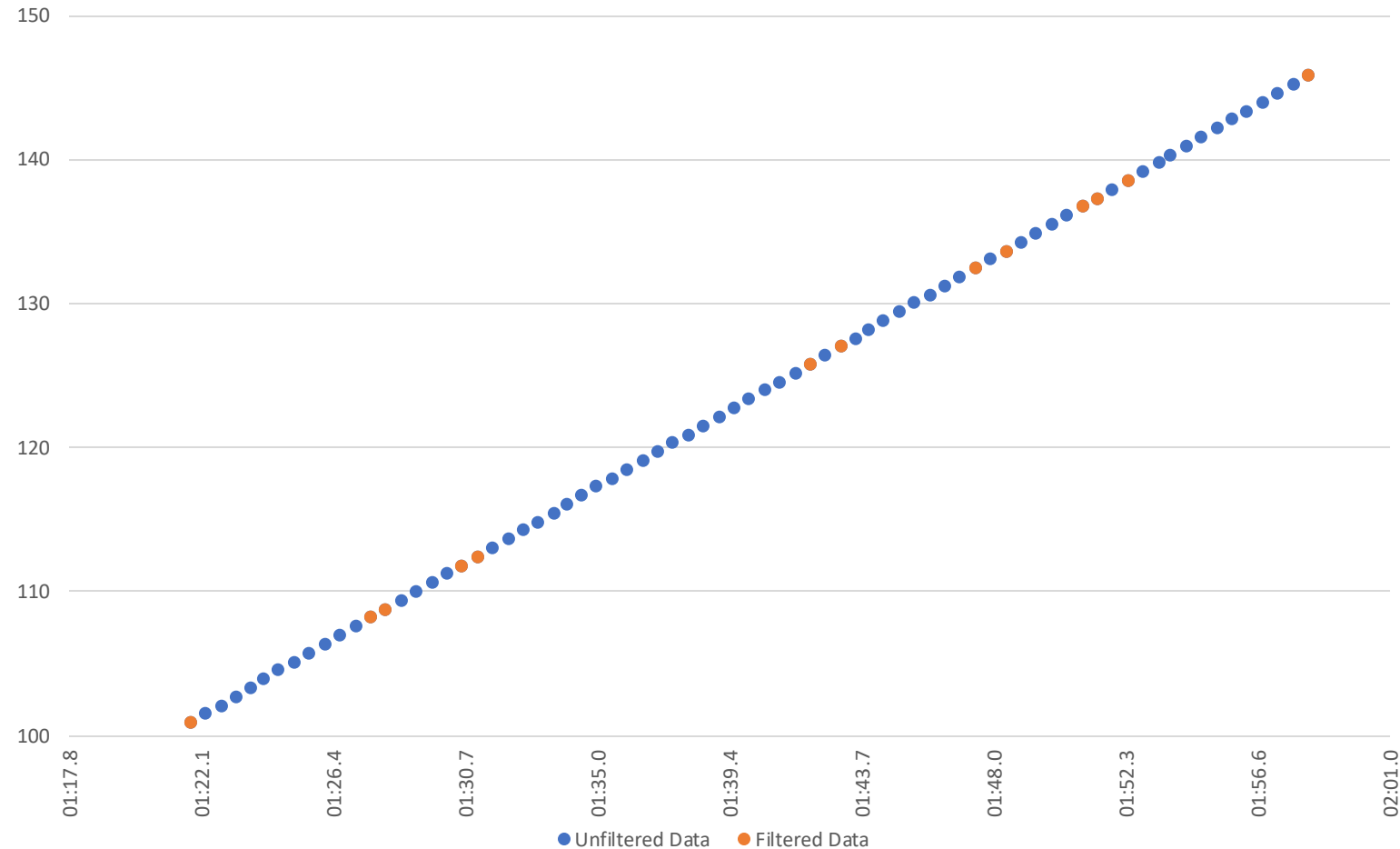
Do we really need this many events to be stored?

01.01.2022 00:01:21,7 100,9286  
01.01.2022 00:01:22,2 101,5357  
01.01.2022 00:01:22,7 102,1429  
01.01.2022 00:01:23,2 102,7500  
01.01.2022 00:01:23,7 103,3571  
01.01.2022 00:01:24,1 103,9643  
01.01.2022 00:01:24,6 104,5714  
01.01.2022 00:01:25,1 105,1786  
01.01.2022 00:01:25,6 105,7857  
01.01.2022 00:01:26,1 106,3929  
01.01.2022 00:01:26,6 107,0000  
01.01.2022 00:01:27,1 107,6071  
01.01.2022 00:01:27,6 108,2143  
01.01.2022 00:01:28,1 108,8214  
01.01.2022 00:01:28,6 109,4286  
01.01.2022 00:01:29,1 110,0357  
01.01.2022 00:01:29,6 110,6429  
01.01.2022 00:01:30,1 111,2500  
01.01.2022 00:01:30,6 111,8571  
01.01.2022 00:01:31,1 112,4643  
01.01.2022 00:01:31,6 113,0714  
01.01.2022 00:01:32,1 113,6786  
01.01.2022 00:01:32,6 114,2857  
01.01.2022 00:01:33,1 114,8929  
01.01.2022 00:01:33,6 115,5000  
01.01.2022 00:01:34,0 116,1071  
01.01.2022 00:01:34,5 116,7143  
01.01.2022 00:01:35,0 117,3214  
01.01.2022 00:01:35,5 117,9286  
01.01.2022 00:01:36,0 118,5357  
01.01.2022 00:01:36,5 119,1429  
01.01.2022 00:01:37,0 119,7500  
01.01.2022 00:01:37,5 120,3571  
01.01.2022 00:01:38,0 120,9643  
01.01.2022 00:01:38,5 121,5714  
01.01.2022 00:01:39,0 122,1786  
01.01.2022 00:01:39,5 122,7857  
01.01.2022 00:01:40,0 123,3929  
01.01.2022 00:01:40,5 124,0000  
01.01.2022 00:01:41,0 124,6071  
01.01.2022 00:01:41,5 125,2143  
01.01.2022 00:01:42,0 125,8214  
01.01.2022 00:01:42,5 126,4286  
01.01.2022 00:01:43,0 127,0357  
01.01.2022 00:01:43,5 127,6429  
01.01.2022 00:01:43,9 128,2500  
01.01.2022 00:01:44,4 128,8571  
01.01.2022 00:01:44,9 129,4643  
01.01.2022 00:01:45,4 130,0714  
01.01.2022 00:01:45,9 130,6786  
01.01.2022 00:01:46,4 131,2857  
01.01.2022 00:01:46,9 131,8929  
01.01.2022 00:01:47,4 132,5000  
01.01.2022 00:01:47,9 133,1071  
01.01.2022 00:01:48,4 133,7143  
01.01.2022 00:01:48,9 134,3214  
01.01.2022 00:01:49,4 134,9286  
01.01.2022 00:01:49,9 135,5357  
01.01.2022 00:01:50,4 136,1429  
01.01.2022 00:01:50,9 136,7500  
01.01.2022 00:01:51,4 137,3571  
01.01.2022 00:01:51,9 137,9643  
01.01.2022 00:01:52,4 138,5714  
01.01.2022 00:01:52,9 139,1786  
01.01.2022 00:01:53,4 139,7857  
01.01.2022 00:01:53,8 140,3929  
01.01.2022 00:01:54,3 141,0000  
01.01.2022 00:01:54,8 141,6071  
01.01.2022 00:01:55,3 142,2143  
01.01.2022 00:01:55,8 142,8214  
01.01.2022 00:01:56,3 143,4286  
01.01.2022 00:01:56,8 144,0357  
01.01.2022 00:01:57,3 144,6429  
01.01.2022 00:01:57,8 145,2500  
01.01.2022 00:01:58,3 145,8571

01.01.2022	00:01:21,7	100,9286
01.01.2022	00:01:27,6	108,2143
01.01.2022	00:01:28,1	108,8214
01.01.2022	00:01:30,6	111,8571
01.01.2022	00:01:31,1	112,4643
01.01.2022	00:01:42,0	125,8214
01.01.2022	00:01:43,0	127,0357
01.01.2022	00:01:47,4	132,5000
01.01.2022	00:01:48,4	133,7143
01.01.2022	00:01:50,9	136,7500
01.01.2022	00:01:51,4	137,3571
01.01.2022	00:01:52,4	138,5714

## Tip #2: Data Density and Data Patterns

Do we really need this many events to be stored?







## Tip #2: Data Density and Data Patterns

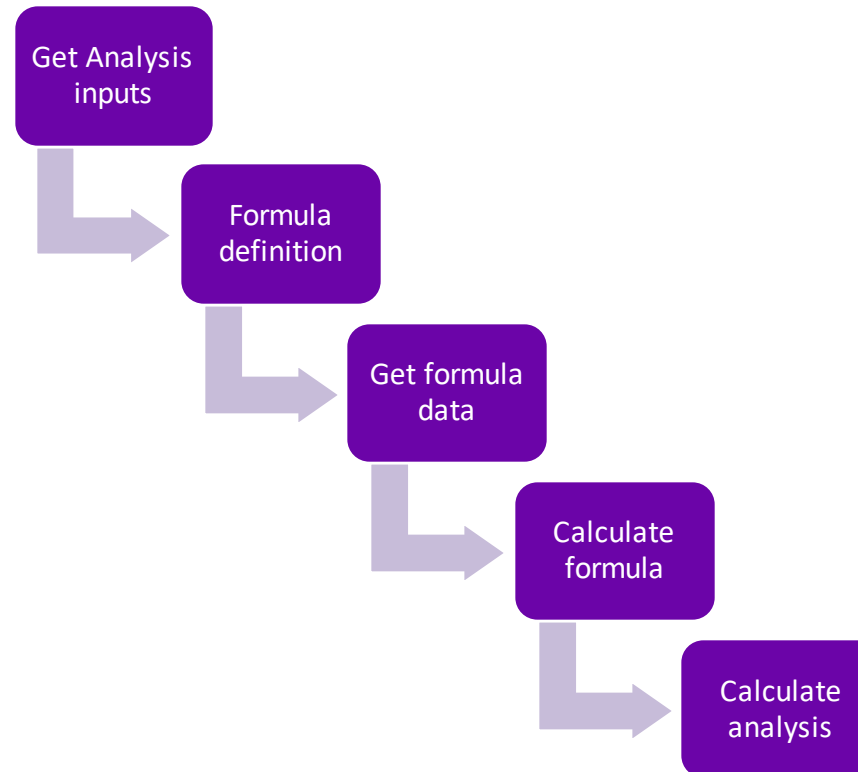
Do we really need this many events to be stored?

- Do not send more data to AVEVA PI Server than needed
  - Review Exception and Compression settings
  - Review Data Source
- Use periodic scheduling to control data density

## Tip #3: Input Attributes

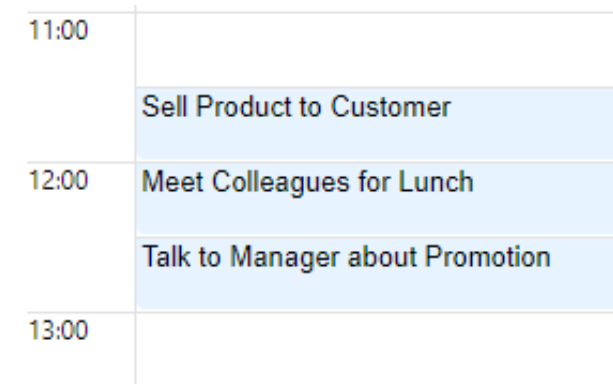
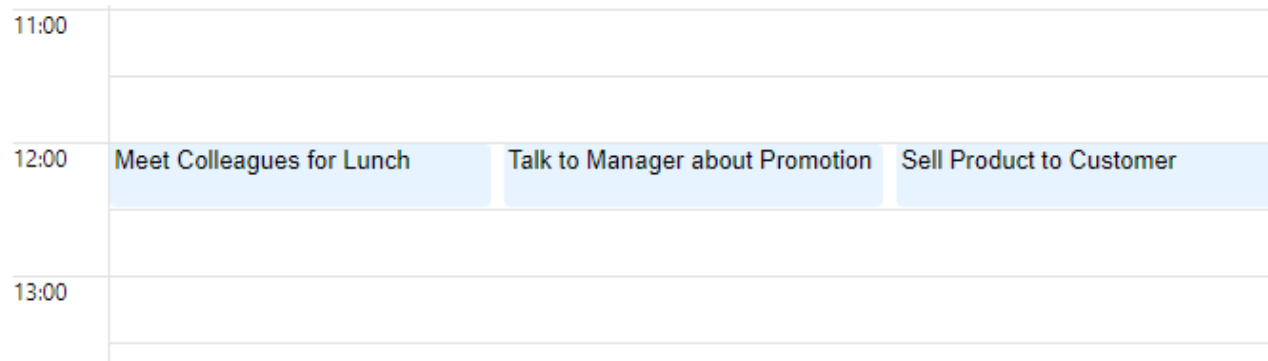
### Where does our data come from?

- Use PI Points wherever possible
- For Table Lookups
  - Use Parametrized Queries
  - Keep Tables as small as possible
- Try to avoid Formula Data References
- Try to avoid extensive Analysis Data References



## Tip #4: Scheduling

How can we help planning an execution?





## Tip #4: Scheduling

How can we help planning an execution?

- Use templates
- Periodic scheduling gives you control
  - Use offsets
- Natural scheduling is controlled by the data source

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# Monitoring PI Analysis Performance

a.k.a. Finding the ~~needle~~ in the haystack  
*elephant*



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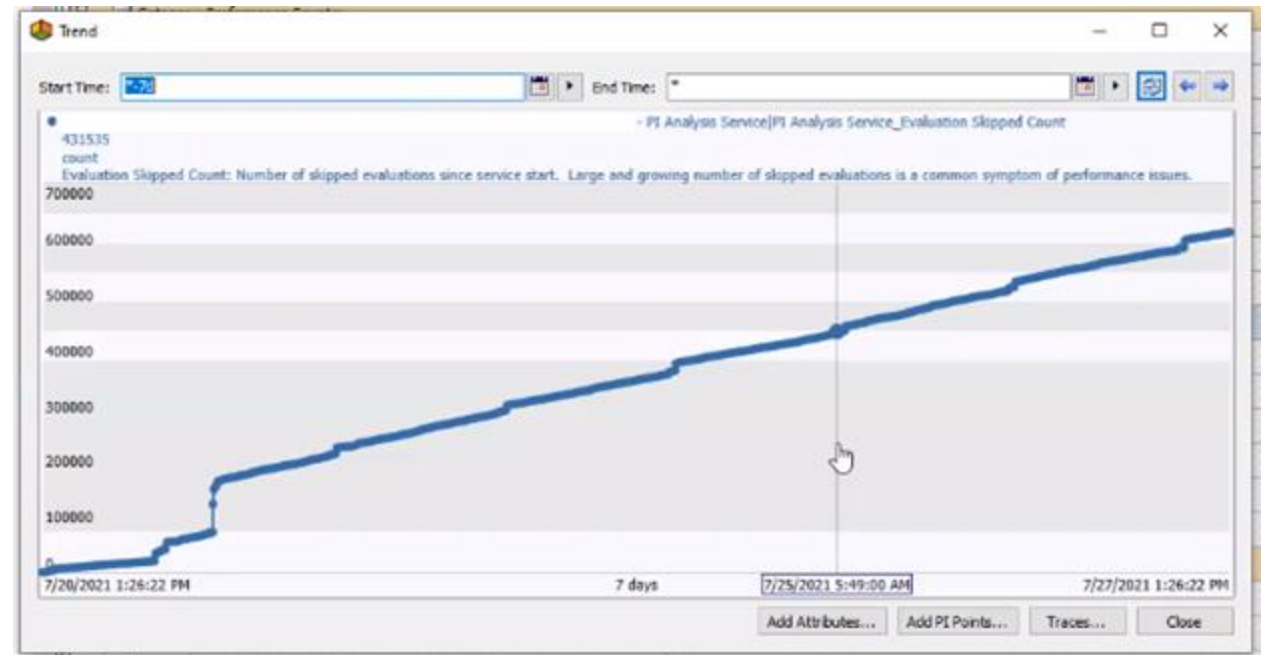
# What does a struggling PI Analysis Service look like?

- **Evaluation Skipped Count** keeps increasing
- **Maximum Latency** is high
- **Evaluation Count** has reached max capacity

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# Proactive monitoring

- Use PI Interface for Performance Monitor
- Build logic to alert for issues
- Services engagement available to assist



# Trademarks of a bad analysis

- Long-running
- Calculated too often
- Long dependency chain





## How can I tell which analyses are misconfigured?

- The Past
  - Analysis performance metrics were hidden and difficult to understand
  - Not organized in a way to compare one analysis template to another
  - Required customers to contact support or schedule a Service engagement

**Analysis Service Statistics**

- Plug-ins
  - EventFrame
  - Natural
  - PerformanceEquation
  - PerformanceEquation\_EventFrame
  - Rollup
- Service summary
  - ManagerStatistics**
  - ProcessorStatistics
  - RecalculationProcessorStatistics
- Service details
  - ServiceStartupStatistics
  - AnalysesConfigurationStatistics
    - TimeRuleToAnalysesCount
    - AnalysisRuleToAnalysesCount
    - StatusToAnalysesCount
    - RankToCalculationCount
  - CalculationStatistics
    - CalculationStatisticsForCalculationGroups
    - CalculationPoolStatistics
    - CacheStatistics
    - CalculationStatistics

**Pending Operations**  
No pending operations

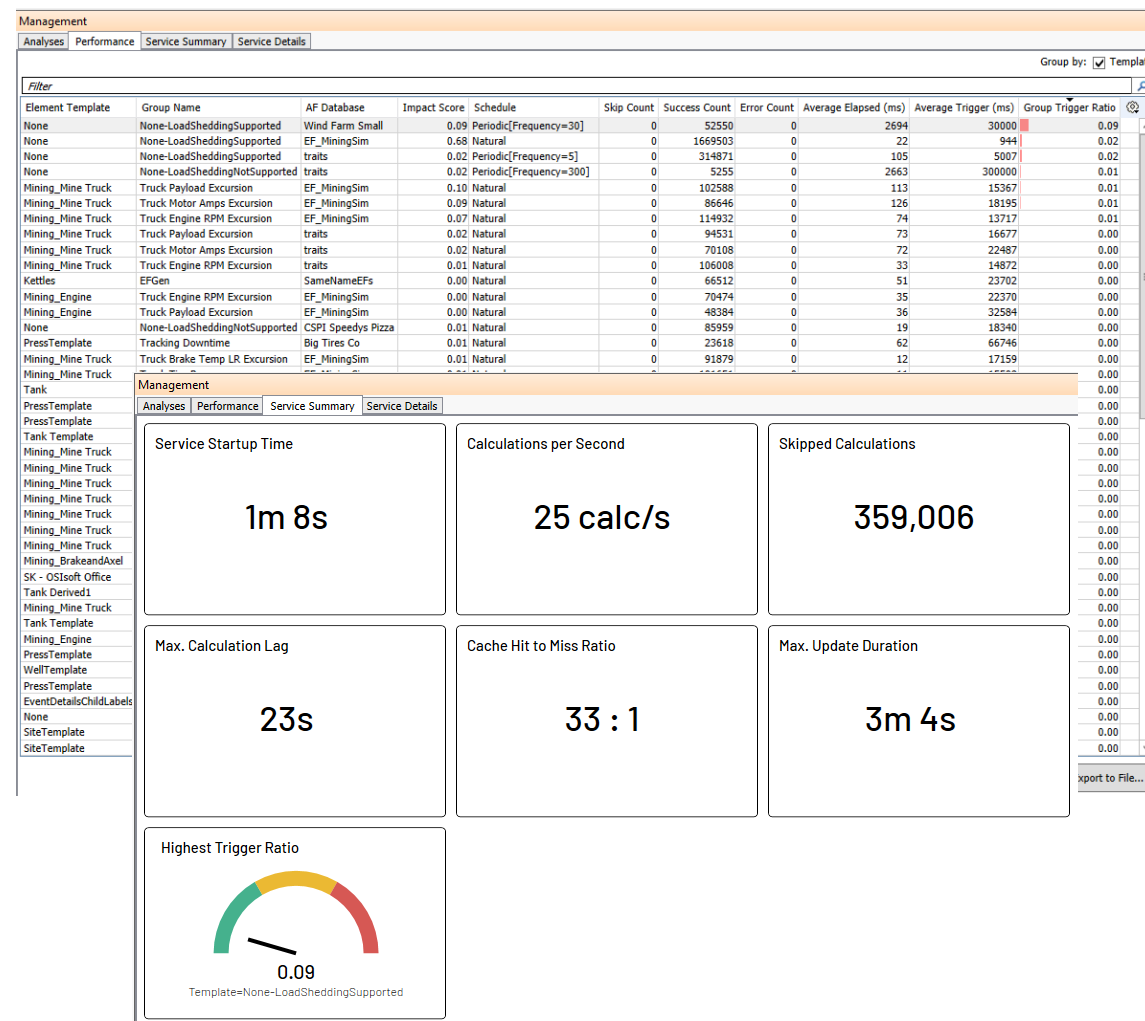
View Analysis Service Statistics  
Edit Analysis Service Configuration  
Open Recalculation Log Folder

	Value
ProcessorCount	1
J	8.73099658430841E-05
s	385495040
s	19830226944
PhysicalMemory	9817104384
FreeMemory	17179398144

Refresh Save Close

# How can I tell which analyses are misconfigured?

- The Future – PI AF Client 2018 SP3 Patch 4
  - Enhancements and usability improvements in PI System Explorer Management plug-in
  - Additional analysis views for analysis and service performance
  - Easily identify expensive analytics/analysis templates
  - Visually represent Analysis service health

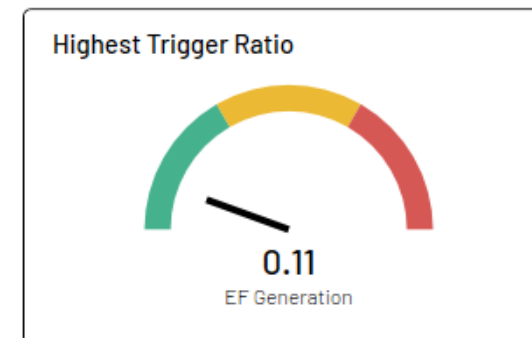


# New Analysis Performance Metrics

- **(Group) Trigger Ratio**

- Measures efficiency of analysis template
- $\text{Average Elapsed} \div \text{Average Trigger}$
- Keep it under 1!

Average Elapsed (ms)	Average Trigger (ms)	Group Trigger Ratio
221	2000	0.11
415	15000	0.03
414	15000	0.03
87	5004	0.02
99	10007	0.01
27	3003	0.01
27	3003	0.01
24	3003	0.01
24	3003	0.01
24	3003	0.01
24	3003	0.01



# New Analysis Performance Metrics

- **Impact Score**

- Overall impact the template's instances have on the server
- Combines efficiency of Trigger Ratio with number of instances of analysis template

Average Analysis Count	Group Trigger Ratio	Impact Score
4000	0.11	441.79
6000	0.03	165.96
6000	0.03	165.72
5000	0.02	87.33
7500	0.01	67.03
7500	0.01	66.55
7500	0.01	60.34
7500	0.01	57.76
7500	0.01	57.02
7500	0.01	57.00
7500	0.01	56.96

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# Demo

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# Summary

- Follow best practices to avoid issues
  - Best practices for analyses
    - [Use Variables](#)
    - [Data Density and Data Pattern](#)
    - [Input Attributes](#)
    - [Scheduling](#)
  - Monitoring the Analysis Service and AF Analytics
    - Identify struggling Analysis Services
    - Proactive monitoring
    - Leverage PI AF Client 2018 SP3 Patch 4 for monitoring analysis performance

If you run into issues today, contact us!



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# Questions?

Please wait for the microphone  
State your name and company



# Please remember to...

Navigate to this session in the mobile  
app to complete the survey.




# Thank you

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